# APPENDIX F
# TOTAL MAXIMUM DAILY LOADS

## F.1 SEDIMENT

### F.1.1 Overview

A percent reduction approach was used for the sediment TMDLs within this document because there is uncertainty associated with the loads derived from the source assessment, and using the estimated sediment loads creates a rigid perception that the loads are absolutely conclusive. However, because daily loads are a required product of TMDL development and percent reductions are most relevant at an annual scale, loads within this appendix are expressed as daily loads. Daily loads should not be considered absolutely conclusive and may be refined in the future as part of the adaptive management process. The TMDLs may not be feasible at all in locations within the watershed, but if the allocations are followed, sediment loads are expected to be reduced to a degree that the sediment targets are met and beneficial uses are no longer impaired.

### F.1.2 Approach

The average annual sediment loads determined from source assessments (**Section 5.0**) were used, along with historical flow and suspended sediment data from the Big Hole River, to determine average daily sediment loads for water bodies in the Middle and Lower Big Hole TPA. A sediment rating curve was developed using daily flow and suspended solids load data collected from 1960 through 1964 at the USGS gage on the Big Hole River near Melrose, MT (Station 6025500) (**Figure F-1**). The gage near Melrose was selected based on its period of record (1923-current) and amount of suspended solids data.

The daily mean discharge based on 84 years of record (1923-2007) at the USGS gage was then plugged into the equation for the sediment rating curve to get a daily suspended sediment load. The suspended sediment load is only a fraction of the total load from the source assessment, but provides an approximation of the relationship between sediment and flow in the Big Hole River. Based on the sum of the calculated daily sediment loads, a daily percentage relative to the annual suspended sediment load was calculated for each day. The daily percentages were then applied to the total average annual loads associated with the TMDL percent reductions from **Section 5.0** to determine the average daily load. To conserve resources, this appendix contains daily loads for the Wise River as an example. As discussed in **Section 5.6.26**, the TMDL for the Wise River is a 34 percent reduction in the total average annual sediment load, which is roughly equivalent to 7,921 tons/year. The daily percentages discussed above were then multiplied by the annual load of 7,921 tons to get a daily expression of the Wise River TMDL (**Figure F-2, Table F-1**). Although the relationship between sediment and flow is likely different within the 303(d) Listed tributaries in the Middle and Lower Big Hole Watershed than in the Big Hole River, it was used to determine average daily loads because it is the best available data and TMDL implementation activities will not be driven by the daily loads. The daily loads are a composite of the allocations, but as allocations are not feasible on a daily basis, they are not contained within this appendix. If

desired, daily allocations may be obtained by applying allocations provided in **Section 5.6** to the daily load. Daily loads for all other TMDLs may be derived by using the daily percentages in **Table F-1** and the TMDLs expressed as an average annual load, which are discussed in **Section 5.6** and also provided in **Table F-2**.
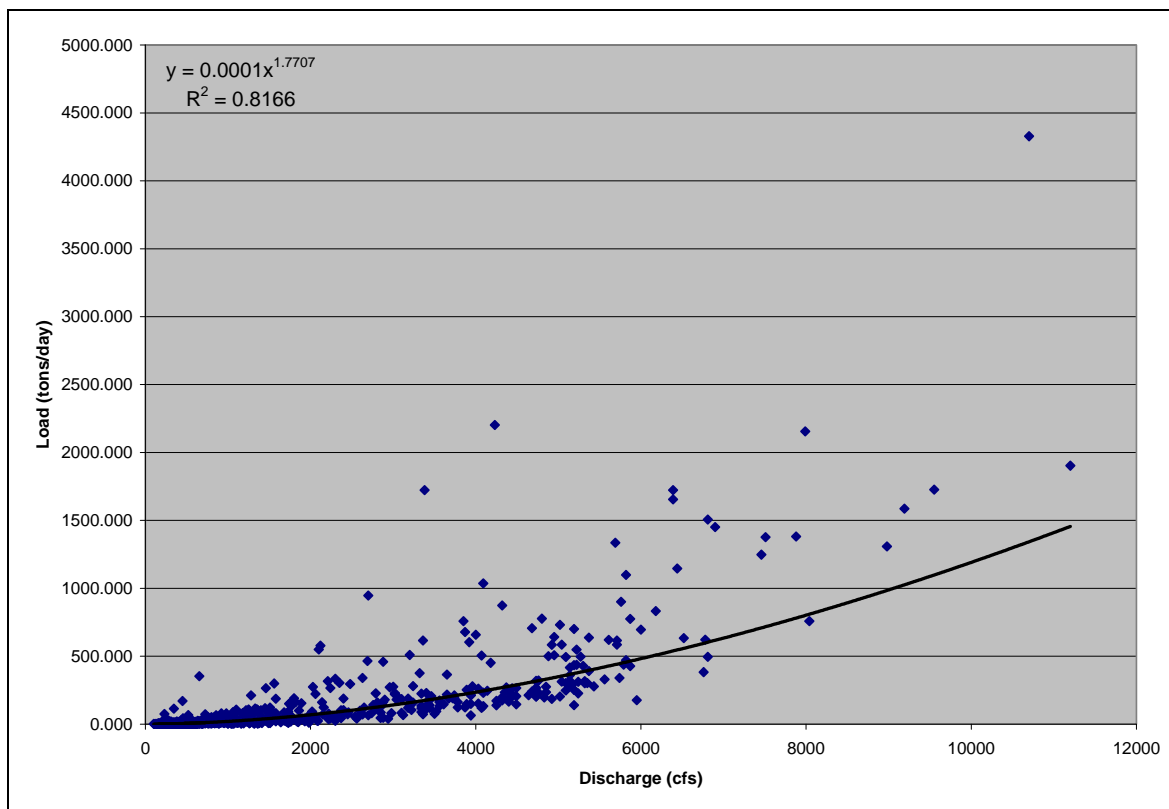

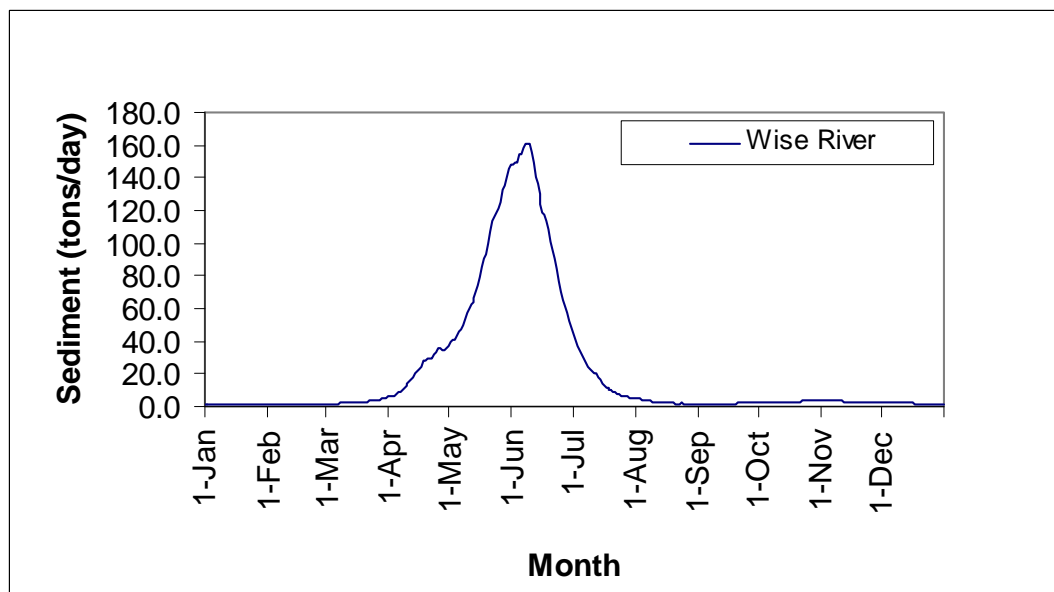
**Figure F-1. Sediment Rating Curve for the Big Hole River**



**Figure F-2. Average Daily Sediment Load for the Wise River**

**Table F-1. Daily Sediment TMDL for the Wise River.**

| Month | Day | Daily % of annual load | Wise River TMDL (tons/day) | Month | Day | Daily % of annual load | Wise River TMDL (tons/day) |
|---|---|---|---|---|---|---|---|
| Jan | 1 | 0.02% | 1.7 | Feb | 17 | 0.02% | 1.7 |
| Jan | 2 | 0.02% | 1.7 | Feb | 18 | 0.02% | 1.7 |
| Jan | 3 | 0.02% | 1.7 | Feb | 19 | 0.02% | 1.7 |
| Jan | 4 | 0.02% | 1.6 | Feb | 20 | 0.02% | 1.7 |
| Jan | 5 | 0.02% | 1.6 | Feb | 21 | 0.02% | 1.7 |
| Jan | 6 | 0.02% | 1.6 | Feb | 22 | 0.02% | 1.7 |
| Jan | 7 | 0.02% | 1.6 | Feb | 23 | 0.02% | 1.8 |
| Jan | 8 | 0.02% | 1.6 | Feb | 24 | 0.02% | 1.7 |
| Jan | 9 | 0.02% | 1.6 | Feb | 25 | 0.02% | 1.8 |
| Jan | 10 | 0.02% | 1.6 | Feb | 26 | 0.02% | 1.8 |
| Jan | 11 | 0.02% | 1.6 | Feb | 27 | 0.02% | 1.8 |
| Jan | 12 | 0.02% | 1.6 | Feb | 28 | 0.02% | 1.8 |
| Jan | 13 | 0.02% | 1.6 | Feb | 29 | 0.02% | 1.8 |
| Jan | 14 | 0.02% | 1.6 | Mar | 1 | 0.02% | 1.8 |
| Jan | 15 | 0.02% | 1.6 | Mar | 2 | 0.02% | 1.8 |
| Jan | 16 | 0.02% | 1.6 | Mar | 3 | 0.02% | 1.8 |
| Jan | 17 | 0.02% | 1.6 | Mar | 4 | 0.02% | 1.8 |
| Jan | 18 | 0.02% | 1.6 | Mar | 5 | 0.02% | 1.8 |
| Jan | 19 | 0.02% | 1.6 | Mar | 6 | 0.02% | 1.9 |
| Jan | 20 | 0.02% | 1.6 | Mar | 7 | 0.02% | 1.9 |
| Jan | 21 | 0.02% | 1.5 | Mar | 8 | 0.02% | 2.0 |
| Jan | 22 | 0.02% | 1.5 | Mar | 9 | 0.03% | 2.0 |
| Jan | 23 | 0.02% | 1.6 | Mar | 10 | 0.03% | 2.1 |
| Jan | 24 | 0.02% | 1.6 | Mar | 11 | 0.03% | 2.1 |
| Jan | 25 | 0.02% | 1.6 | Mar | 12 | 0.03% | 2.3 |
| Jan | 26 | 0.02% | 1.6 | Mar | 13 | 0.03% | 2.3 |
| Jan | 27 | 0.02% | 1.6 | Mar | 14 | 0.03% | 2.4 |
| Jan | 28 | 0.02% | 1.5 | Mar | 15 | 0.03% | 2.4 |
| Jan | 29 | 0.02% | 1.5 | Mar | 16 | 0.03% | 2.6 |
| Jan | 30 | 0.02% | 1.5 | Mar | 17 | 0.04% | 2.8 |
| Jan | 31 | 0.02% | 1.6 | Mar | 18 | 0.04% | 2.9 |
| Feb | 1 | 0.02% | 1.6 | Mar | 19 | 0.04% | 2.9 |
| Feb | 2 | 0.02% | 1.7 | Mar | 20 | 0.04% | 3.0 |
| Feb | 3 | 0.02% | 1.6 | Mar | 21 | 0.04% | 3.1 |
| Feb | 4 | 0.02% | 1.6 | Mar | 22 | 0.04% | 3.3 |
| Feb | 5 | 0.02% | 1.6 | Mar | 23 | 0.04% | 3.4 |
| Feb | 6 | 0.02% | 1.7 | Mar | 24 | 0.04% | 3.5 |
| Feb | 7 | 0.02% | 1.7 | Mar | 25 | 0.05% | 3.7 |
| Feb | 8 | 0.02% | 1.7 | Mar | 26 | 0.05% | 3.8 |
| Feb | 9 | 0.02% | 1.7 | Mar | 27 | 0.05% | 4.1 |
| Feb | 10 | 0.02% | 1.7 | Mar | 28 | 0.06% | 4.8 |
| Feb | 11 | 0.02% | 1.7 | Mar | 29 | 0.07% | 5.4 |
| Feb | 12 | 0.02% | 1.7 | Mar | 30 | 0.07% | 5.6 |
| Feb | 13 | 0.02% | 1.6 | Mar | 31 | 0.07% | 5.8 |
| Feb | 14 | 0.02% | 1.6 | Apr | 1 | 0.08% | 6.1 |
| Feb | 15 | 0.02% | 1.6 | Apr | 2 | 0.08% | 6.5 |
| Feb | 16 | 0.02% | 1.6 | Apr | 3 | 0.08% | 6.6 |

**Table F-1. Daily Sediment TMDL for the Wise River.**

| Month | Day | Daily % of annual load | Wise River TMDL (tons/day) | Month | Day | Daily % of annual load | Wise River TMDL (tons/day) |
|---|---|---|---|---|---|---|---|
| Apr | 4 | 0.09% | 7.4 | May | 21 | 1.36% | 107.6 |
| Apr | 5 | 0.10% | 8.3 | May | 22 | 1.44% | 113.8 |
| Apr | 6 | 0.12% | 9.2 | May | 23 | 1.46% | 115.9 |
| Apr | 7 | 0.13% | 10.5 | May | 24 | 1.50% | 118.5 |
| Apr | 8 | 0.15% | 11.8 | May | 25 | 1.52% | 120.7 |
| Apr | 9 | 0.17% | 13.4 | May | 26 | 1.58% | 125.5 |
| Apr | 10 | 0.18% | 14.4 | May | 27 | 1.67% | 132.2 |
| Apr | 11 | 0.20% | 15.7 | May | 28 | 1.70% | 135.0 |
| Apr | 12 | 0.22% | 17.1 | May | 29 | 1.78% | 140.7 |
| Apr | 13 | 0.23% | 18.3 | May | 30 | 1.84% | 145.9 |
| Apr | 14 | 0.25% | 19.9 | May | 31 | 1.87% | 148.2 |
| Apr | 15 | 0.28% | 21.9 | Jun | 1 | 1.87% | 148.2 |
| Apr | 16 | 0.30% | 23.5 | Jun | 2 | 1.88% | 148.8 |
| Apr | 17 | 0.31% | 24.8 | Jun | 3 | 1.88% | 148.8 |
| Apr | 18 | 0.35% | 27.6 | Jun | 4 | 1.95% | 154.7 |
| Apr | 19 | 0.35% | 27.9 | Jun | 5 | 1.95% | 154.7 |
| Apr | 20 | 0.36% | 28.7 | Jun | 6 | 2.00% | 158.3 |
| Apr | 21 | 0.38% | 29.9 | Jun | 7 | 2.04% | 161.4 |
| Apr | 22 | 0.38% | 29.9 | Jun | 8 | 2.04% | 161.4 |
| Apr | 23 | 0.40% | 31.7 | Jun | 9 | 2.03% | 160.8 |
| Apr | 24 | 0.43% | 33.8 | Jun | 10 | 1.96% | 155.3 |
| Apr | 25 | 0.45% | 35.7 | Jun | 11 | 1.89% | 149.4 |
| Apr | 26 | 0.45% | 36.0 | Jun | 12 | 1.78% | 140.7 |
| Apr | 27 | 0.44% | 34.7 | Jun | 13 | 1.73% | 136.7 |
| Apr | 28 | 0.43% | 34.4 | Jun | 14 | 1.65% | 130.5 |
| Apr | 29 | 0.45% | 35.7 | Jun | 15 | 1.56% | 123.4 |
| Apr | 30 | 0.47% | 37.0 | Jun | 16 | 1.50% | 119.1 |
| May | 1 | 0.50% | 39.6 | Jun | 17 | 1.48% | 116.9 |
| May | 2 | 0.51% | 40.2 | Jun | 18 | 1.43% | 113.3 |
| May | 3 | 0.52% | 41.2 | Jun | 19 | 1.37% | 108.6 |
| May | 4 | 0.55% | 43.6 | Jun | 20 | 1.27% | 100.5 |
| May | 5 | 0.58% | 45.7 | Jun | 21 | 1.21% | 96.1 |
| May | 6 | 0.60% | 47.5 | Jun | 22 | 1.15% | 90.8 |
| May | 7 | 0.62% | 49.3 | Jun | 23 | 1.06% | 83.8 |
| May | 8 | 0.67% | 53.3 | Jun | 24 | 0.97% | 76.6 |
| May | 9 | 0.73% | 57.6 | Jun | 25 | 0.89% | 70.2 |
| May | 10 | 0.76% | 60.3 | Jun | 26 | 0.82% | 64.7 |
| May | 11 | 0.79% | 62.3 | Jun | 27 | 0.77% | 60.7 |
| May | 12 | 0.80% | 63.5 | Jun | 28 | 0.72% | 57.2 |
| May | 13 | 0.83% | 66.0 | Jun | 29 | 0.66% | 52.2 |
| May | 14 | 0.89% | 70.2 | Jun | 30 | 0.62% | 48.9 |
| May | 15 | 0.93% | 74.0 | Jul | 1 | 0.56% | 44.3 |
| May | 16 | 1.01% | 79.8 | Jul | 2 | 0.52% | 40.9 |
| May | 17 | 1.08% | 85.7 | Jul | 3 | 0.47% | 37.3 |
| May | 18 | 1.15% | 90.8 | Jul | 4 | 0.43% | 34.4 |
| May | 19 | 1.18% | 93.7 | Jul | 5 | 0.41% | 32.3 |
| May | 20 | 1.26% | 100.0 | Jul | 6 | 0.37% | 29.0 |

**Table F-1. Daily Sediment TMDL for the Wise River.**

| Month | Day | Daily % of annual load | Wise River TMDL (tons/day) | Month | Day | Daily % of annual load | Wise River TMDL (tons/day) |
|---|---|---|---|---|---|---|---|
| Jul | 7 | 0.33% | 26.2 | Aug | 22 | 0.02% | 1.9 |
| Jul | 8 | 0.31% | 24.6 | Aug | 23 | 0.02% | 1.9 |
| Jul | 9 | 0.29% | 23.2 | Aug | 24 | 0.02% | 1.9 |
| Jul | 10 | 0.28% | 21.9 | Aug | 25 | 0.02% | 1.9 |
| Jul | 11 | 0.26% | 20.7 | Aug | 26 | 0.02% | 1.8 |
| Jul | 12 | 0.25% | 19.9 | Aug | 27 | 0.02% | 1.8 |
| Jul | 13 | 0.23% | 18.0 | Aug | 28 | 0.02% | 1.7 |
| Jul | 14 | 0.21% | 16.4 | Aug | 29 | 0.02% | 1.6 |
| Jul | 15 | 0.19% | 14.7 | Aug | 30 | 0.02% | 1.6 |
| Jul | 16 | 0.17% | 13.2 | Aug | 31 | 0.02% | 1.6 |
| Jul | 17 | 0.15% | 12.0 | Sep | 1 | 0.02% | 1.6 |
| Jul | 18 | 0.14% | 11.2 | Sep | 2 | 0.02% | 1.5 |
| Jul | 19 | 0.13% | 10.5 | Sep | 3 | 0.02% | 1.5 |
| Jul | 20 | 0.13% | 10.1 | Sep | 4 | 0.02% | 1.5 |
| Jul | 21 | 0.12% | 9.5 | Sep | 5 | 0.02% | 1.5 |
| Jul | 22 | 0.11% | 9.0 | Sep | 6 | 0.02% | 1.5 |
| Jul | 23 | 0.10% | 8.3 | Sep | 7 | 0.02% | 1.5 |
| Jul | 24 | 0.10% | 7.5 | Sep | 8 | 0.02% | 1.5 |
| Jul | 25 | 0.09% | 6.9 | Sep | 9 | 0.02% | 1.6 |
| Jul | 26 | 0.08% | 6.6 | Sep | 10 | 0.02% | 1.6 |
| Jul | 27 | 0.08% | 6.2 | Sep | 11 | 0.02% | 1.6 |
| Jul | 28 | 0.07% | 5.8 | Sep | 12 | 0.02% | 1.6 |
| Jul | 29 | 0.07% | 5.5 | Sep | 13 | 0.02% | 1.6 |
| Jul | 30 | 0.07% | 5.4 | Sep | 14 | 0.02% | 1.6 |
| Jul | 31 | 0.07% | 5.4 | Sep | 15 | 0.02% | 1.6 |
| Aug | 1 | 0.06% | 5.1 | Sep | 16 | 0.02% | 1.6 |
| Aug | 2 | 0.06% | 4.8 | Sep | 17 | 0.02% | 1.7 |
| Aug | 3 | 0.06% | 4.6 | Sep | 18 | 0.02% | 1.7 |
| Aug | 4 | 0.05% | 4.3 | Sep | 19 | 0.02% | 1.8 |
| Aug | 5 | 0.05% | 4.1 | Sep | 20 | 0.02% | 1.9 |
| Aug | 6 | 0.05% | 3.8 | Sep | 21 | 0.03% | 2.0 |
| Aug | 7 | 0.04% | 3.5 | Sep | 22 | 0.03% | 2.0 |
| Aug | 8 | 0.04% | 3.2 | Sep | 23 | 0.03% | 2.1 |
| Aug | 9 | 0.04% | 3.0 | Sep | 24 | 0.03% | 2.1 |
| Aug | 10 | 0.04% | 2.8 | Sep | 25 | 0.03% | 2.1 |
| Aug | 11 | 0.03% | 2.7 | Sep | 26 | 0.03% | 2.1 |
| Aug | 12 | 0.03% | 2.6 | Sep | 27 | 0.03% | 2.1 |
| Aug | 13 | 0.03% | 2.5 | Sep | 28 | 0.03% | 2.1 |
| Aug | 14 | 0.03% | 2.4 | Sep | 29 | 0.03% | 2.2 |
| Aug | 15 | 0.03% | 2.3 | Sep | 30 | 0.03% | 2.3 |
| Aug | 16 | 0.03% | 2.2 | Oct | 1 | 0.03% | 2.3 |
| Aug | 17 | 0.03% | 2.1 | Oct | 2 | 0.03% | 2.4 |
| Aug | 18 | 0.03% | 2.0 | Oct | 3 | 0.03% | 2.4 |
| Aug | 19 | 0.02% | 2.0 | Oct | 4 | 0.03% | 2.5 |
| Aug | 20 | 0.02% | 1.9 | Oct | 5 | 0.03% | 2.5 |
| Aug | 21 | 0.02% | 1.9 | Oct | 6 | 0.03% | 2.6 |

**Table F-1. Daily Sediment TMDL for the Wise River.**

| Month | Day | Daily % of annual load | Wise River TMDL (tons/day) | Month | Day | Daily % of annual load | Wise River TMDL (tons/day) |
|---|---|---|---|---|---|---|---|
| Oct | 7 | 0.03% | 2.6 | Nov | 22 | 0.03% | 2.6 |
| Oct | 8 | 0.03% | 2.6 | Nov | 23 | 0.03% | 2.4 |
| Oct | 9 | 0.03% | 2.6 | Nov | 24 | 0.03% | 2.5 |
| Oct | 10 | 0.03% | 2.7 | Nov | 25 | 0.03% | 2.7 |
| Oct | 11 | 0.03% | 2.7 | Nov | 26 | 0.03% | 2.6 |
| Oct | 12 | 0.04% | 2.8 | Nov | 27 | 0.03% | 2.5 |
| Oct | 13 | 0.04% | 2.8 | Nov | 28 | 0.03% | 2.4 |
| Oct | 14 | 0.04% | 2.9 | Nov | 29 | 0.03% | 2.4 |
| Oct | 15 | 0.04% | 3.0 | Nov | 30 | 0.03% | 2.3 |
| Oct | 16 | 0.04% | 3.1 | Dec | 1 | 0.03% | 2.4 |
| Oct | 17 | 0.04% | 3.1 | Dec | 2 | 0.03% | 2.5 |
| Oct | 18 | 0.04% | 3.1 | Dec | 3 | 0.03% | 2.5 |
| Oct | 19 | 0.04% | 3.1 | Dec | 4 | 0.03% | 2.4 |
| Oct | 20 | 0.04% | 3.1 | Dec | 5 | 0.03% | 2.2 |
| Oct | 21 | 0.04% | 3.1 | Dec | 6 | 0.03% | 2.1 |
| Oct | 22 | 0.04% | 3.2 | Dec | 7 | 0.03% | 2.1 |
| Oct | 23 | 0.04% | 3.3 | Dec | 8 | 0.02% | 2.0 |
| Oct | 24 | 0.04% | 3.3 | Dec | 9 | 0.03% | 2.0 |
| Oct | 25 | 0.04% | 3.3 | Dec | 10 | 0.03% | 2.0 |
| Oct | 26 | 0.04% | 3.4 | Dec | 11 | 0.03% | 2.1 |
| Oct | 27 | 0.04% | 3.4 | Dec | 12 | 0.03% | 2.1 |
| Oct | 28 | 0.04% | 3.4 | Dec | 13 | 0.03% | 2.0 |
| Oct | 29 | 0.04% | 3.3 | Dec | 14 | 0.03% | 2.0 |
| Oct | 30 | 0.04% | 3.3 | Dec | 15 | 0.03% | 2.0 |
| Oct | 31 | 0.04% | 3.3 | Dec | 16 | 0.02% | 1.9 |
| Nov | 1 | 0.04% | 3.3 | Dec | 17 | 0.02% | 1.9 |
| Nov | 2 | 0.04% | 3.2 | Dec | 18 | 0.02% | 1.8 |
| Nov | 3 | 0.04% | 3.3 | Dec | 19 | 0.02% | 1.7 |
| Nov | 4 | 0.04% | 3.4 | Dec | 20 | 0.02% | 1.8 |
| Nov | 5 | 0.04% | 3.3 | Dec | 21 | 0.02% | 1.8 |
| Nov | 6 | 0.04% | 3.4 | Dec | 22 | 0.02% | 1.8 |
| Nov | 7 | 0.04% | 3.4 | Dec | 23 | 0.02% | 1.9 |
| Nov | 8 | 0.04% | 3.4 | Dec | 24 | 0.02% | 1.8 |
| Nov | 9 | 0.04% | 3.4 | Dec | 25 | 0.02% | 1.8 |
| Nov | 10 | 0.04% | 3.3 | Dec | 26 | 0.02% | 1.8 |
| Nov | 11 | 0.04% | 3.2 | Dec | 27 | 0.02% | 1.8 |
| Nov | 12 | 0.04% | 3.2 | Dec | 28 | 0.02% | 1.8 |
| Nov | 13 | 0.04% | 3.1 | Dec | 29 | 0.02% | 1.7 |
| Nov | 14 | 0.04% | 3.1 | Dec | 30 | 0.02% | 1.7 |
| Nov | 15 | 0.04% | 3.1 | Dec | 31 | 0.02% | 1.7 |
| Nov | 16 | 0.04% | 2.9 | | | | |
| Nov | 17 | 0.04% | 3.0 | | | | |
| Nov | 18 | 0.04% | 3.0 | | | | |
| Nov | 19 | 0.04% | 2.9 | | | | |
| Nov | 20 | 0.03% | 2.7 | | | | |
| Nov | 21 | 0.03% | 2.6 | | | | |

**Table F-2. Sediment TMDLs expressed as an average annual load (tons/year).**

| Stream Segment | Water Body # | TMDL expressed as average annual load (tons/year) |
|---|---|---|
| **Big Hole River** between Divide Cr and Pintlar Cr (Middle segment) | MT41D001_020 | 138,377 |
| **Birch Creek** headwaters to the National Forest Boundary | MT41D002_090 | 1,749 |
| **Birch Creek** from National Forest Boundary to mouth (Big Hole R) | MT41D002_100 | 3,010 |
| **California Creek** from headwaters to mouth (French Cr-Deep Cr) | MT41D003_070 | 907 |
| **Camp Creek** from headwaters to mouth (Big Hole R) | MT41D002_020 | 2,464 |
| **Corral Creek** from headwaters to mouth (Deep Cr) | MT41D003_130 | 341 |
| **Deep Creek** from headwaters to mouth (Big Hole R) | MT41D003_040 | 7,647 |
| **Delano Creek** from headwaters to mouth (Jerry Cr) | MT41D003_030 | 107 |
| **Divide Creek** from headwaters to mouth (Big Hole R) | MT41D002_040 | 4,210 |
| **Elkhorn Creek** headwaters to mouth (Jacobson Cr-Wise R) | MT41D003_220 | 383 |
| **Fishtrap Creek** confluence of West & Middle Fks to mouth (Big Hole) | MT41D003_160 | 2,649 |
| **French Creek** headwaters to mouth (Deep Creek) | MT41D003_050 | 2,928 |
| **Gold Creek** from headwaters to mouth (Wise R) | MT41D003_230 | 592 |
| **Grose Creek** from headwaters to mouth (Big Hole R) | MT41D002_060 | 174 |
| **Jerry Creek** from headwaters to mouth (Big Hole R) | MT41D003_020 | 2,159 |
| **Lost Creek** in the Lower Big Hole Watershed | MT41D002_180 | 584 |
| **Moose Creek** from headwaters to mouth (Big Hole R at Maiden Rock) | MT41D002_050 | 1,778 |
| **Oregon Creek** headwaters to mouth (California Cr - French Cr - Deep) | MT41D003_080 | 131 |
| **Pattengail Creek** from headwaters to mouth (Wise R) | MT41D003_210 | 2,412 |
| **Rochester Creek** from headwaters to mouth (Big Hole R) | MT41D002_160 | 1,555 |
| **Sawlog Creek** tributary to Big Hole R | MT41D004_230 | 307 |
| **Sevenmile Creek** from headwaters to mouth (Deep Cr) | MT41D003_110 | 384 |
| **Sixmile Creek** from headwaters to mouth (California Cr) | MT41D003_090 | 401 |
| **Soap Creek** from headwaters to mouth (Big Hole R) | MT41D002_140 | 1,011 |
| **Trapper Creek** from headwaters to mouth (Big Hole R) | MT41D002_010 | 2,589 |
| **Wise River** from headwaters to mouth (Big Hole R) | MT41D003_200 | 7,921 |

## F.2 TEMPERATURE DAILY TMDLS AND INSTANTANEOUS TEMPERATURE LOADS

The temperature TMDLs are the sum of waste load allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources (**Equation F-1**). Although there are no point sources in this watershed and therefore are no WLAs. In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream.

**Equation F-1.**

TMDL = $\Sigma$WLA + $\Sigma$LA + MOS.

Where:

$\Sigma$WLA = Waste Load Allocation = Pollutants from NPDES Point Sources
$\Sigma$LA = Load Allocation = Pollutants from Nonpoint Sources + Natural Sources
MOS = Margin of Safety

Total maximum daily loads are based on the loading of a pollutant to a water body. Federal Codes indicate that for each thermally listed water body the total maximum daily thermal load cannot be exceeded in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife. Such estimates shall take into account the water temperatures, flow rates, seasonal variations, existing sources of heat input, and the dissipative capacity of the identified waters. The following approach for setting numeric temperature TMDLs considers all of the factors listed above.

The numeric daily thermal loads (TMDLs) and instantaneous thermal load (ITLs) presented in this appendix apply to all portions of the temperature impaired waters in Middle and Lower Big Hole River TMDL Planning Areas. This appendix provides daily and instantaneous heat loading limits for the middle and lower segments of Big Hole River and Divide Creek. All waters in this planning area are classified as A-1 or B-1. Montana's temperature standard for A-1 or B-1 water body classifications are depicted in **Figure F-3**.
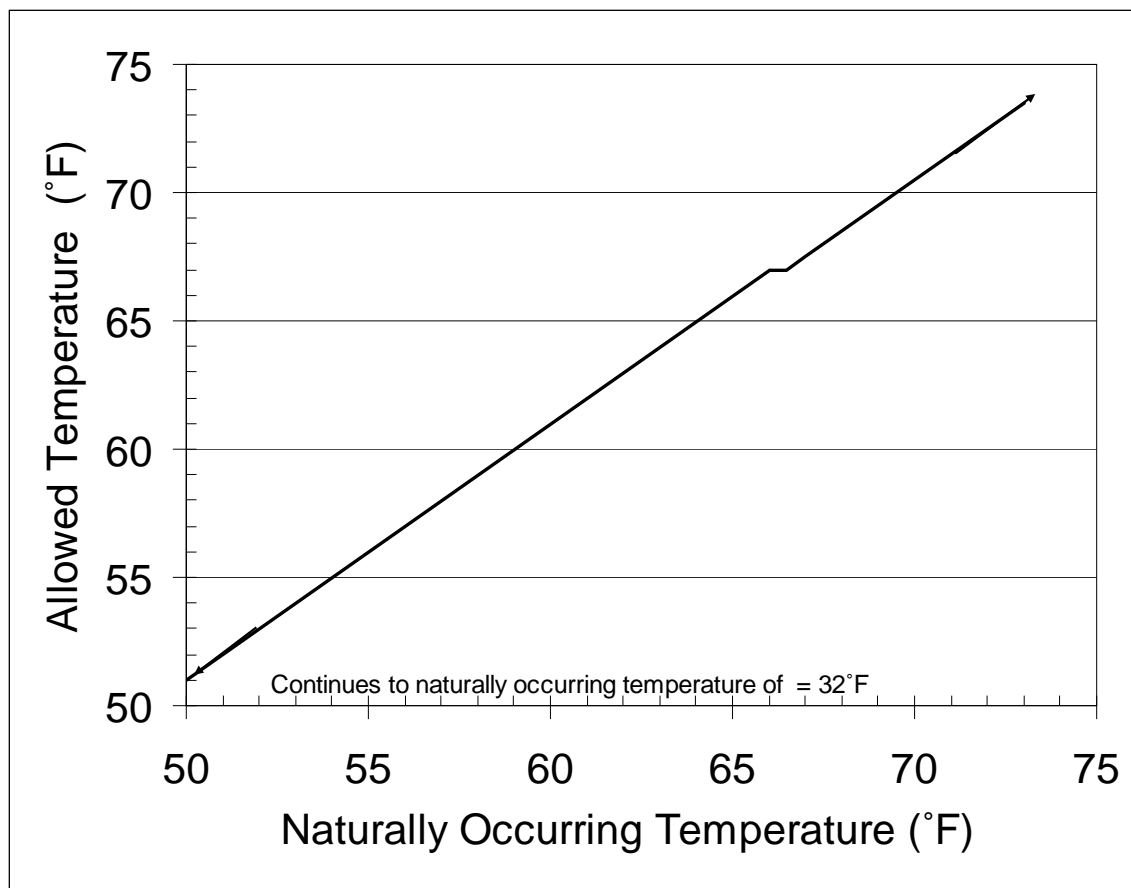
**Figure F-3. In-stream Temperatures Allowed by Montana's A-1 and B-1 Classification Temperature Standard**

## F.2.1 Daily Thermal Load

The allowed temperature can be calculated using Montana's A-1 classification temperature standards (**Figure F-3**) and using a modeled or estimated naturally occurring daily average temperature. The daily average total maximum load at any location in the water body is provided **Equation F-2**. The daily allowable loading is expressed as the allowable loading to the liquid form of the water in the stream. This is defined as the kilocalorie increase associated with the warming of the water from 32°F to the temperature that represents compliance with Montana's temperature standard as determined from **Figure F-3**.

**Equation F-2**

$$(\Delta - 32) * (Q) * (1.36 * 10^6) = TMDL$$

Where:

$\Delta$ = allowed temperatures from **Figure F-3** using daily temperature condition
Q = average daily discharge in cubic feet per second (CFS)
TMDL = daily TMDL in Calories (kilocalories) per day above water's melting point
Conversion factor = 1359209

There are no point sources that increase water temperatures, and therefore, no wasteload allocations for the watershed. The TMDL load allocation for each stream is a combination of the ½ °F allowable loading shared between the human caused sources without reasonable land, soil, and water conservation practices in addition to the naturally occurring loading as defined in state law. Because temperatures are estimated to be naturally above 66 °F at times, one-half degree allowable increase in temperature is used for the TMDL and allocations. See the main document for more information about surrogate allocations, which are more applicable to restoration approaches. The surrogate allocations should meet the daily thermal load. The daily numeric TMDL allocation is equal to the load allocation shared by all human-caused sources without reasonable land, soil, and water conservation practices plus the load allocated to naturally occurring temperatures as shown in **Equation F-3**.

**Equation F-3**

Load Allocation = Allowable Human Sources + Naturally Occurring Thermal Loads

Where:

Naturally Occurring Thermal Loads = (Naturally Occurring Temperature (°F) from Modeling Scenarios -32)*(Discharge (CFS))*( $1.36*10^6$ )

Allowable Human Sources above naturally occurring conditions = (1/2°F)*( $1.36*10^6$ )*(Discharge (CFS))

## F.2.2 Instantaneous Thermal Load

Because of the dynamic temperature conditions during the course of a day, an instantaneous thermal load (ITL) is also provided for temperature. For temperature, the daily average thermal conditions are not always an effective indicator of impairment to fisheries. The heat of the day is usually the most stressful timeframe for salmonids and char. Also, in high altitudes, thermal impacts that heat during the day may produce advanced cooling conditions during the night so that the daily temperature fluctuations increase greatly, with potentially significant negative impacts to fish without much impact on daily average temperature conditions. Therefore, Montana provides an instantaneous thermal load to protect during the hottest timeframes in mid to late afternoon when temperatures are most stressful to the fishery, which is the most sensitive use in reference to thermal conditions.

The instantaneous load is computed by the second. The allowed temperature can be calculated using Montana's A-1 or B-1 classification temperature standards (**Figure F-3**) and using a modeled or estimated naturally occurring instantaneous temperature. The instantaneous total maximum load (per second) at any location in the water body is provided by **Equation F-4**. The allowable loading over a second is expressed as the allowable loading to the liquid form of the water in the stream. This is defined as the kCal increase associated with the warming of the water from 32°F to the temperature that represents compliance with Montana's temperature standard as determined from **Figure F-3**.

**Equation F-4**

$(\Delta - 32)*(Q)*(15.73)$ = Instantaneous Thermal Load (ITL)

Where:

$\Delta$ = allowed temperatures from **Figure F-3** using daily temperature condition
$Q$ = instantaneous discharge in CFS
ITL = Allowed thermal load per second in kilocalories per day above water's melting point
Conversion factor = 15.73

There are no point sources that increase water temperatures, and therefore, no instantaneous wasteload allocations for the watershed. The ITL load allocation for each stream is a combination of the 1/2°F allowable loading shared between the human caused sources without reasonable land, soil, and water conservation practices in addition to the naturally occurring loading as defined in state law. Because temperatures are estimated to be naturally above 66 °F at times, one-half degree allowable increase in temperature is used for the TMDL and allocations. See the main document for more information about surrogate allocations, which are more applicable to restoration approaches. The surrogate allocations should meet the ITL. The ITL allocation is equal to the load allocation shared by all human caused sources without reasonable land, soil and water conservation practices plus the load allocated to naturally occurring temperatures as shown in **Equation F-5**.

**Equation F-5**

Load Allocation = Allowable Human Sources + Naturally Occurring Thermal Loads

Where:

Naturally Occurring Thermal Loads = (Naturally Occurring Temperature (°F) from Modeling Scenarios -32)*(Discharge (CFS))*(15.73)

Allowable Human Sources above naturally occurring conditions =
(1/2°F)*(15.73)*(Discharge (CFS))

## F.2.3 Margins of Safety, Seasonal Variations and Future Sources

See **Section 7** of the main document for this discussion.

## F.2.4 Example Numeric TMDL Application for the Big Hole River above Pintlar Creek

**Big Hole River Daily Thermal Load Example Application**
Monitoring along with Heatsource and SNTEMP (Stream Network Temperature Model) models were completed on the Big Hole River and Divide Creek (**Appendices I and J**). Modeling scenarios used reference riparian shade conditions throughout the watershed along with an estimated increase of 15 percent irrigation efficiency increase during warm summer months to

estimate naturally occurring temperatures where all reasonable land, soil, and water conservation practices are in place with existing land use. Naturally occurring average daily temperature at the Big Hole River's confluence with Pintlar Creek during a hot day of summer 2006 was estimated at 67.3°F using SNTEMP modeling. This temperature is then used to determine the allowable temperature according to **Figure F-3**, Montana's temperature standard. The allowable mean daily temperature is estimated at 67.8°F during the hottest days of the summer. **Equation F-2** from above is used to calculate the upper portion of the Middle segment Big Hole River TMDL during the hottest days of the summer. This location was one of the most heavily impacted thermal areas found along the Middle Segment of the Big Hole River during the source assessment.

**Example:**

$$(\Delta-32)*(Q)*(1.36*10^6) = TMDL$$

Where:

$\Delta$ = allowed temperatures from **Figure F-3** using daily temperature condition = **67.8°F**
$Q$ = average daily discharge in cubic feet per second (CFS) = **101cfs**
TMDL = daily TMDL in Calories (kilocalories) per day above water's
melting point = **$4.92*10^9$ kilocal/day**

The Upper Big Hole River load allocation to human caused heat sources not addressed by reasonable land, soil, and water conservation practices for the TMDL is $6.87*10^7$ kilocalories per day. The remainder of the TMDL is appropriated to naturally occurring thermal load. Since there are no NPDES permits that affect water temperature, there is zero waste load allocation. During warm summer days the mean daily temperature of this site exceeds the average daily TMDL. Similar exorcises could be completed for the middle reaches of Divide Creek and the lower reaches lower section of the Big Hole River, but these examples are not provided because they lack utility.

**Big Hole River Instantaneous Thermal Load**
The instantaneous thermal load (ITL) is described as the heat passing a monitoring location per second. The most sensitive timeframe for the fishery occurs during the heat of the day for the hottest period of the year. The same modeling described earlier in this appendix was used to model daily maximum temperatures. The naturally occurring daily maximum temperature in the Big Hole River near Pintlar Creek's confluence during one of the hottest days of summer 2006 was estimated at 73.5°F using a SNTEMP model. This temperature is then used to determine the allowable temperature according to **Figure F-3**, Montana's temperature standard. Therefore, the allowable maximum temperature during this timeframe is estimated at 74.0°F during a hot summer day. **Equation F-4** from above is used to calculate the upper portion of the Middle Big Hole River's ITL during one of the hottest days of the summer.

**Example:**
  ($\Delta$-32)*(Q)*(15.73) = Instantaneous Thermal Load (ITL)

  Where:
  $\Delta$ = allowed temperatures from **Figure F-3** using instantaneous temperature condition = **74.0°F**
  Q = average daily discharge in cubic feet per second (CFS) = **101cfs**
  ITL = Allowed thermal load per second in kilocalories per day above water's melting point = **66,700 kilocal/second**

The Middle Big Hole River's load allocation to human caused heat sources not addressed by reasonable land, soil, and water conservation practices for the ITL is 794 kilocalories per second. Since there are no NPDES permits that affect water temperature, there is zero waste load allocation. The remainder of the load allocation for the ITL is apportioned to naturally occurring thermal loading. During the hottest days of the summer the ITL is greatly surpassed in the Big Hole River near the confluence with Pintlar Creek (near the upstream limit of the middle Big Hole River Segment). This is the most heavily impacted reach of the Big Hole River regarding thermal impacts. This indicates that Montana's temperature standard at this site is not being met during an important timeframe for the most sensitive use. Similar exorcises could be completed for the middle reaches of Divide Creek and the lower reaches lower section of the Big Hole River and the ITL would be exceeded, but these examples are not provided because they lack utility. Any measured location on the temperature impaired streams could apply to the ITL.